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SpMM, more computational intensive operation for sparse matrix in Krylov subspace methods

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Krylov subspace methods are used to solve linear system with large sparse matrix, where main operations consist of the SpMV, operation of sparse matrix multiplication to vector and the inner product operation. The most common data structure to keep the sparse matrix is called CSR that only keeps nonzero entries in each row with compressed format. However, computational complexity of SpMV is very low because loaded coefficient data are only used once against element of the vector and it is known that the benchmark of HPCG only can achieve less than 5 percent of the peak performance of the modern super computer, even if the matrix data form a regular stencil pattern.
It is very important to enhance computational intensity of such operation with sparse matrix. If we need to solve linear system with several multiple right hand side, SpMV can be replaced by SpMM and we can expect substantial speed up thanks to recycling of coefficient data by keeping them in the cache memory. For the most standard linear system with single right hand side, we need to prepare several search vectors from a single residual vector. One candidate of such multiple search vectors is set of search vectors during convergence of local problems that are obtained by matrix decomposition. By combining restarting procedure and spectral analysis of the group of search vectors, convergence of such CG method can be accelerated.
Unfortunately numerical libraries for sparse matrix product is not intensively developed, and then I would to find a way to prepare optimized sparse BLAS and sparse linear solvers.

JLESC topic

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